PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in or relating to Supersonic Wave Piezo-Electric Crystal Oscillators or Vibrators

We, USAG ULTRASCHALL-GESELLSCHAFT ZURICH, a body corporate organised under the laws of the confederation of Switzerland, of 61, Seastrasse, Zurich 2, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to supersonic wave piezo-electric crystal oscillators or vibrators primarily for use in therapeutic treatment and diagnosis. The invention seeks to provide a vibrator or oscillator arrangement for use in such treatment or diagnosis comprising a so-called "massage head" which shall be of compact design, enable a very high intensity of output to be obtained and shall not only ensure, even when high voltages are used, perfect electrical protection of the body of the patient under treatment and painless transmission of the supersonic vibrations to said patient, but shall also conduct away and otherwise diminish in an efficient manner, the heat generated in the oscillatory system. These objects are achieved, according to the invention, by exciting the piezo-electric crystal oscillator proper of the arrangement by a voltage curve similar to that of a band pass filter and so chosen in relation to the natural resonance curve of the oscillator or vibrator that the voltage across the frame rises steeply giving relatively uniform radiation over a wide band. This excitation may be provided by a coil of maximum inductance and low capacity located as close as possible to the crystal oscillator. Disposed on that side of the vibrator from which the supersonic waves are emitted is a metal plate the thickness of which is an integral multiple of half the supersonic wavelength ($\lambda/2$) and preferably, double said half wave-length (i.e. λ). The result of this arrangement is that the surface of contact between the vibrator and the metal exactly coincides with the nodal pressure point, i.e. in the loop of the supersonic waves, so that said surface of contact is mechanically relieved.

In a preferred embodiment of the invention, the metal plate is firmly joined mechanically to the vibrator proper, by cementing with a solvent-free cement. A very advantageous cement for use for this purpose is a polymerization cement whose state of aggregation at operating temperatures is that of a solid. Instead of such a polymerization cement it is possible to use a thin film of oil or a thin film of a consistent grease or of Canada balsam or the like, by means of which the piezo-electric resonator is joined mechanically to the metal plate, but a joint so made will be sufficiently firm only if the two elements joined together are both individually tuned to the same natural frequency.

The invention is illustrated in and further explained in the accompanying drawings which represent schematically a number of embodiments. In the figures like parts are designated by like references where possible.

In order to enable the quartz to operate against a layer of low characteristic impedance, thereby securing improved matching of the oscillator to the driving high-frequency generator, it may be found expedient to dispose between the quartz and the metal plate an appropriately tuned layer of a medium of low characteristic impedance and high tensile strength such as that known under the Registered Trade Mark "Trolitul", unvulcanized rubber, wax, gelatine, or the like. Where a cemented on plate is used its characteristic impedance may be reduced in the manner shown in Fig. 5 by providing said plate at the cemented joint with recesses. These recesses (see

Fig. 5) are of such depth and cross-section that while good transmission of sound from the quartz 2 to the plate 1 is achieved, the plate 1 acquires, by reason of the metal removed to form the recesses an acoustic characteristic impedance which is lower than it would otherwise be. The localised weakening of the material due to the provision of the recesses may also be so arranged that, as a result of mutual interference (as in a Fresnel zone plate) of the energy beams transmitted therethrough, influencing of the transmitted field in a desired manner is obtained.

In order to prevent part of the supersonic output being transmitted or radiated off in the rearward direction, i.e., by the back electrode located on the rear side of the piezo-electric resonator, a mass 3 of metal or a mass of some other material, such as ceramic material, which is superficially metallized (see Fig. 1) may be provided said mass being out of tune with the oscillating system and being used as the back electrode. This mass 3 whilst so arranged as to be in excellent electrical contact with the oscillating system, is at the same time arranged in such slight mechanical contact therewith that no or practically no energy is withdrawn from the oscillating system thereby. Such a back electrode structure may be conveniently constituted by a metal plate which, is either well roughened or sand-blasted or provided with mechanically-produced grooves or the like on the surface thereof facing the piezo-electric resonator. In this way it is possible to ensure that the contact between the metal plate serving as the back electrode and the adjacent surface (which may conveniently be metallized) of the piezo-electric resonator consists substantially of points or lines only, the greater portion of the surface of the back electrode being out of mechanical contact with the piezo-electric resonator while nevertheless, satisfactory electrical contact betwen the two parts is maintained. In embodiments of the invention in which the vibrator consists of a plurality of separate pieces 2^{I} 2^{II} 2^{III} 2^{IIII} of quartz (a so-called " mosaic " quartz) as in Fig. 2 the back electrode may consist of a flexible metallic mass 4, e.g. a copper-wire net, which is pressed against the crystal by a resilient cushion or pad (5). The disposition and polarization of the separate crystals are such as to give the desired radiation characteristics.

In cases where a metal plate is used as the back electrode, it is advisable, in order to prevent undesired corona discharges from arising on said back electrode, so to arrange the design that the metal plate projects slightly beyond the edge of the piezo-electric resonator and is well rounded on all sides, for example in Figs. 1 and 2. This arrangement offers the advantage that it is possible to operate the oscillator, without hesitation with relatively very high voltage, as may be desired where a very high density of output is required. As a result the risk of a rounded off design such as illustrated in Figs. 1 and 2, which might result in the formation of a luminous arc dangerous to the piezo-electric resonator, is reduced or eliminated. In this connection it is of advantage to make the electrode of such thickness, or at least to make the edge of the electrode of such width, that as homogeneous a field as possible is set up between the electrode and the outer jacket which, in use, is grounded.

Further protection against undesired flash-overs may be achieved, as shown in Fig. 4, by mounting a length of cylindrical or (as shown) tapering metal tube 10, coaxial with the piezo-electric resonator and the back electrode whilst being suitably spaced therefrom. The result given by the provision of a length of tube in this way is that, (as in the well-known horn lightning arrestors used in heavy-current engineering) any luminous arc forming from the back electrode 3 to the front plate 1 and likely to endanger the quartz 2 by heating effect, is immediately deflected outwards by electrical forces and continues burning across the shortest connection between the back electrode 3 and the protecting tube. In this position, however, the arc no longer constitutes a danger to the quartz and does not in any way jeopardize its useful life.

Maximum efficiency of operation of the oscillatory system is obtained when, not only is rearward transmission and radiation (e.g. by the back electrode) of the supersonic output prevented as far as possible, but, in addition, when the diameter of the vibrator plate is tuned to the corresponding natural radial frequency. Also it is desirable to prevent as far as possible any radial deflection of the generated vibrations in the direction of the handle, which is necessarily fitted to a vibrator for therapeutical use and is indicated (broken away) in the lower part of Fig. 3. This may be done, as illustrated in Figure 4 by providing in that face of the metal plate 1 adjacent the output side of the piezo-electric resonator one or more annular grooves 11 (one such groove is shown in Figure 4) whose diameter and depth are chosen to choke down lateral propagation of vibrations beyond the groove or grooves and tune

the plate in the radial direction also and thus improve propagation in the axial direction. In this way the undesirable transmission of vibrations to the casing of the device, the handle thereof and thence to the hand of the doctor using the device is largely avoided.

In order to render ineffective as far as possible the waste heat inevitably generated in the oscillator, and to deflect said waste heat from the closure plate 1 itself, it is of advantage, as shown in Figure 3 to provide a special filling mass 9 behind the metallic mass, for instance a metal plate, serving as the back electrode. This filling mass is for electrical reasons, preferably not in direct contact with said metallic mass. The purpose of this filling mass 9 is to increase what may be termed the thermal capacity of the structural members of the oscillator. A filling mass arranged in this way is particularly effective if its melting point or point of transformation is in the vicinity of the maximum desired operating temperature and if at the same time it possesses as high as possible a heat of fusion or of transformation. It is expedient to employ a filling mass whose melting or transformation point is as near possible to 37° C. as this is the temperature found most agreeable when physical contact with the instrument takes place. Examples of substances that can be used to constitute such a mass are phenol, lauric acid, capric acid, *p*-toluidine and similar organic compounds, and also low-melting metallic alloys, or such inorganic salts as sodium thiosulphate or Glauber's salt. Tetracresyl silicate, for instance, and many other substances can be used as a mass of high thermal capacity.

Finally, very efficient removal of waste heat arising in the oscillator can be achieved by adding to said oscillator a metallic body of high thermal capacity (a cooler) against which the oscillator is held in any convenient known manner by a suspension device during the periods of non-use, so that, while not in use the oscillator yields to the cooler the whole or a part of any heat it may have accumulated. It is also possible to design the oscillator suspension device itself as a cooler. The cooler may be arranged in any convenient manner automatically to operate a switching arrangement to switch off or reduce the output of the driving high frequency generator when the oscillator is out of use. Moreover, the arrangement can be such that when the electric massage-head is laid down, it mechanically, or by electrical contact with the suspension device, switches off or chokes down the high-frequency generator by which it is driven. In this manner it is possible to achieve the result, for instance, that the filling mass 9 already referred to, which may have gradually melted during a period of use of the oscillator and thereby withdrawn thermal energy from the vibrator head, very rapidly sets again during the intervals between use.

Heating up of the oscillator while running idle can be further reduced by operating the oscillator at a frequency lying immediately below the undamped natural frequency of the system. In the damped condition, work will then be performed practically at the peak of the radiation curve.

The maximally-damped condition can also be achieved by filling the spaces, between the oscillator and the body of the patient to be treated, as fully as possible with a suitable coupling substance or liquid. In carrying out the invention this can be achieved by arranging for the coupling substance to emerge from the edges of the oscillator itself. To this end the coupling substance can be accommodated in a small storage space in the oscillator itself or may be supplied from an external source.

By adopting the various expedients above described it is possible to construct a vibrator head for supersonic wave treatment which will enable very intense supersonic energy to be generated and transmitted or radiated in a compact space, without the vibrator head either becoming hotter than would be permissible or being endangered on the normal flash over voltage being exceeded, by the formation of a luminous arc.

It is often advisable to transmit or collect the wave radiation via an intermediate or attachment member. In order to keep the resonance qualities of the vibrator as high as possible for favourable adaptation or matching, it is advisable to manufacture such intermediate or attachment members of a material of low characteristic impedance such as aluminium, the materials known under the Registered Trade Mark " Elektron " and " Trolitul ", which is either tuned to the frequency or exhibits on its anterior face concave or convex curvature, or a curvature which is concave centrally and convex elsewhere, in order to produce focusing of the radiation or elimination of the natural maximum of interference. In this case it is advantageous to provide ducts or channels to the front surface (i.e. the surface against the patient) of the attachments for passing coupling fluid emerging from the vibrator. Hollows in the attachments may be filled

with a material of different sound velocity characteristics from that of the attachments in order to ensure good contact with the medium to be subjected to supersonic vibration.

In some forms of stationary treatment it is often required to allow the radiation to take effect from several directions or over large surfaces even on pronouncedly curved areas of the body. This can be done by the simultaneous use of a plurality of separate oscillators pressed against the appropriate areas of the body by springs or similar elastic devices or by means of a suitable stand. For the stationary irradiation of pronouncedly curved areas of the body the invention may be used to provide an elastically deformable vibrator surface comprising a multiplicity of flat oscillators held together by elastic members such as springs or rubber. Such an arrangement is illustrated in Figure 6. Owing to the widely varying operating requirements which may be encountered it is advisable so to arrange and design the vibrator as a whole and the individual elements which compose it that they can, as shown in Figure 6 be assembled as desired to form a long row, a square, and so on. The individual vibrators are in this case independent radiators each surrounded by an insulating casing 12 and jointly pressed by an elastic medium such as a sponge-rubber pad 13 against the area of the body to be treated. It is also possible, for the purposes of such forms of treatment to press against the appropriate areas of the body an embodiment as illustrated in Figure 7 and which is in the form of what may be termed a "supersonic pad or cushion" of predetermined form similar to a heating pad, in which cushion are individual non-interchangeably mounted vibrators interconnected by elastic means, and having a common back electrode in the form of a flexible metallic net 4^1 which is pressed up by a pad or cushion 5^1 or a material of low electrical loss such for instance as chips of the material known under the Registered Trade Mark "Trolitul". The whole is covered with a flexible envelope 12^1. For the purpose of pressing on this "supersonic pad", metal plates of predetermined curvature may be used, said curvature either coinciding with the curvature of the bodily area to be treated or providing the desired focusing of the radiators which are in this way arranged to radiate convergently. Should it be desired to achieve these effects with a single plate, it is advisable to make the latter of lead. It is also possible to assemble the individual radiators permanently for specific frequently-repeated cases such as nasal treatment, treatment of the knee, and so on. Such assemblies and the "cushions" or "pads" described may be arranged to be secured to the appropriate areas of the body for treatment, by means of elastic members, springs, elastic bands or the like, or pressed against said areas by a flexibly-operating stand.

Vibration radiating surfaces of greater size can also be produced, as shown in Figure 8, by arranging one or more radiators to act directly or via an intermediate layer obliquely upon a metal plate 14 the arrangement being such that and the frequency, and thickness and material of the plate being so selected that the said plate 14 is excited to maximum flexional vibrations. These vibrations are emitted from the piezo-electric resonator or resonators 2 along the plate and radiate into the body 15 bearing thereagainst. In order to prevent damping and consequent uneven radiation, it is advisable to operate with a plurality of exciters. If the plate 14 is not made too thick—and this is easy to ensure—it can be so bent as to be readily adapted to the area of the body to be treated. The plate or strip 14 can, here again, be shaped to suit a particular part of the body for which it may be intended. With stationary treatment, exteremely reliable coupling is advisable. This may be ensured by a fluid or gel-like coupling medium that is conveniently prevented from leaking out by a coupling chamber located in front and consisting of deformable walls 16 (e.g. of lead) with a vulcanised-on rubber gasket 17. After application to the body, the coupling substance can be forced in or removed by suction or pressure through feed pipes. Thus an oscillator or vibrator structure may comprise one or more oscillators or vibrators as claimed arranged to radiate obliquely and either directly or through an intermediate layer or recesses into a metal plate or strip of pre-determined configuration or adapted to be flexed into a desired shape, the thickness, material and angle of radiation of the plate being such that the said plate is excited with flexional waves i.e. waves such as are indicated in Figure 8 which propagate themselves in serpentine fashion in a metal strip which is caused to oscillate by being struck obliquely to its plane—which are radiated into the body to be treated through a coupling fluid adapted to be carried in and emerge from the vibrator or from the edges thereof, either directly or through an intevening coupling chamber filled with the coupling fluid. The

coupling chamber may comprise a leaden edge, a rubber gasket and a length of tube, means being provided for heating the coupling fluid in the chamber and for forcing said fluid through said chamber by compression or suction.

In the treatment of tumours, improved treatment by vibration is often achieved at high temperatures. Such temperatures may be obtained by providing for supplementary electrical heating of the coupling substance or by use of this invention in combination with diathermic or short-wave treatment. It is also advisable during treatment, especially during treatment of tumours, in order to avoid periosteal pain, and so on, to apply the radiated vibration at a very oblique angle, for which purpose the coupling chamber can be suitably designed. In this way tangential waves—i.e. waves which are propagated along the surface of the body —can be excited. This is of great importance therapeutically. Such tangential components can be provoked artificially, even when the radiated vibration is applied vertically, by the suspension of small elastic centres—i.e. points which have different elasticity from their surroundings—such as minute air bubbles, and so on in the vicinity of the surface of the body. Such tangential components can also be obtained by incorporating in the coupling fluid, in the vicinity of the surface of the skin, a metallic net of appropriate mesh-size.

Coupling fluid can also be accommodated in a bladder of very thin rubber rigidly or removably mounted in front of the emitting surface, which bladder, to ensure good transmission of sound, may be wetted with oil or a gel-like substance (such as a coater with added material such as tragacanth, or aluminium monostearinicum) which again can be carried in and fed out from the oscillator.

It is very convenient for neurological treatment to design a therapeutic supersonic vibrator in accordance with the invention in such a way that it can be used in conjunction with a supersonic diagnostic instrument, as in this way the cost of a high-frequency generator and oscillator can be saved. The Pohlman visual sound-receiver, which has hitherto been used only in the testing of materials, would appear to be particularly suitable in this connection as a diagnostic instrument. In the combined apparatus it is necessary to provide the precautionary measures such as frequency wobbling with the aid of band-filter excitation to ensure uniform radiation over a wide frequency-band. Visual reception can, of course, also be effected by electrical scanning with or without the use of a sound-lens, or the diagnostic findings may be derived from a sensitive power-indicator which indicates the mechanical quality of the medium subjected to the sound-waves. By known means it is also possible to render acoustically and directly observable, by means of amplifiers, rectifiers and loud-speakers, the fluctuation in the radiated power as different areas of the body are played upon. Furthermore, the therapeutic apparatus can also, by means of a reliable power meter, be used for indirect diagnosis by determining the radiated power that causes turbidity, due to the presence of torn-off particles of tissue, when played into a fluid in which a specimen of the tissue is suspended. In this way the integral tensile strength of the tissue can be determined, from which datum diagnostic conclusions may be drawn.

For the purpose of effectively introducing loosely dissociated medicaments, a combination of ultra-sound and iontophoresis has proved satisfactory, in which combination either the massage-head itself or the closely and flexibly fitting vibrator pad serves as the counter-electrode. In this method the electrophoretic substance is, in manner known *per se* placed, in absorbent paper, between the oscillator and the skin, or fitted into the coupling chamber hereinbefore referred to.

As, in many applications, the therapeutic effect of supersonic treatment increases as the temperature rises, a combination of supersonic and diathermic treatment has also proved highly effective. A method of providing for such combination consists in arranging the radiator, held by an insulating handle, so that it acts as an electrode through a tuned plate of the material known under the Registered Trade Mark "Trolitul", or the introduction of the radiated vibrations can be effected through an insulating coupling fluid, such as oil, located in a coupling chamber consisting of an insulating edge. In the case of protuberant areas of the body surface (tumours, and so on) it is possible, in order to achieve higher electrical field intensities, to excite the short-wave field perpendicularly to the direction of radiant introduction of the vibrations, for instance by incorporating the short-wave electrodes in an edging made of insulating material of the coupling chamber.

What we claim is:—

1. A piezo electric oscillator or vibrator arrangement comprising an oscillator or vibrator proper adapted to transmit or radiate supersonic waves of high power,

in a preferred direction and with low loss, into a solid or almost solid medium characterised in that the piezo-electric resonator is not surrounded by oil and is excited with a voltage curve similar to that of a band-pass filter and so chosen, in relation to the natural resonance curve of the oscillator or vibrator that the frequency response curve rises steeply giving relatively uniform radiation over a wide band, there being provided on the radiating or output side only of the oscillatory or vibratory system a metal plate whose thickness is an integral number of half wave-lengths of the supersonic waves in the metal.

2. An arrangement as claimed in Claim 1 wherein the multiple is two.

3. An arrangement as claimed in Claim 1 or 2 wherein the piezo-electric resonator is firmly cemented to the metal plate by cement.

4. An arrangement as claimed in Claim 3 wherein the cement is a solvent free polymerization cement.

5. An arrangement as claimed in Claim 1 or 2 wherein the piezo-electric resonator is connected to the metal plate by a tuned or balanced layer of a medium of low characteristic impedance and high tensile strength.

6. An arrangement as claimed in Claim 1 or 2 wherein the characteristic impedance of the coupled metal plate is reduced by recesses tuned or balanced as to cross-section and depth.

7. An arrangement as claimed in Claim 6 wherein said recesses are of such form (e.g., as in a Fresnel zone plate) that a predetermined radiation field is produced.

8. An arrangement as claimed in any of Claims 1 to 4, wherein there is a back element constituted by a metallic mass which is out of tune with the oscillatory or vibratory system and which has a roughened or grooved surface which bears against the rear side of a metallised piezo-electric resonator in such a way as to be in the slight point-like or line-like contact therewith, said surface projecting somewhat beyond the edge of said piezo-electric resonator and being well rounded on all sides and of such thickness or shape as to ensure the formation in use of a substantially homogeneous electrical field.

9. An arrangement as claimed in any of the preceding claims and wherein an oscillatory or vibratory system assembled from a plurality of separate pieces of crystal with a back electrode consisting of a flexible metallic mass, is pressed on by a resilient pad or cushion.

10. An arrangement as claimed in any of the preceding claims wherein the piezo-electric resonator is surrounded by a cylindrical or tapered length of metal tube, coaxial with said resonator and arranged for voltage-limitation purposes at a distance therefrom, and wherein at least one annular groove is provided in the metal plate to choke down the lateral propagation of the oscillatory or vibratory energy beyond the groove and at the same time to improve, by tuning the plate in the radial direction also, the radiation in the axial direction.

11. An arrangement as claimed in any of the preceding claims wherein a filling mass whose melting point, transformation point or evaporation point is approximately 37° C., is disposed in good thermal contact with the oscillator or vibrator.

12. An arrangement as claimed in any of Claims 1 to 10 wherein the oscillator or vibrator proper, when in the state of rest, bears against a filling mass or against a metallic body of high thermal capacity (cooler) arranged to operate a switching arrangement by which the driving high-frequency generator is switched off or reduced in output.

13. An arrangement for transmitting or radiating supersonic waves into a solid or almost solid medium and which is designed for operation at a frequency lying close below the undamped natural frequency of the system whereby waste heat generated during idle running time is reduced.

14. An arrangement as claimed in any of Claims 1—12 and having tuned or balanced anterior attachments or adapters made of a material of low characteristic impedance.

15. An arrangement as claimed in Claim 14 wherein said attachments or adapters are designed to act as sound-lenses.

16. An arrangement as claimed in Claim 15 wherein the attachments or adapters have concave areas filled with a material of sound-velocity characteristics differing from those of the material of which they are made in order to ensure good contact with the medium to be subjected to supersonic vibration.

17. An oscillator or vibrator structure composed of a plurality of flat-built oscillators or vibrators as claimed in any of the preceding claims and so interconnected by detachable elastic members that they can be selectively assembled into any of a plurality of desired shapes adapted to fit closely and elastically against a desired area of a body to be treated.

18. An oscillator or vibrator structure

composed of a plurality of flat built elastically interconnected oscillators or vibrators as claimed in any of Claims 1 to 16 and which have a common flexible back electrode arranged to be pressed against the surface to be treated by an elastic pad or cushion made of substantially dielectrically loss-free material.

19. An oscillator or vibrator structure as claimed in Claim 17 or 18 wherein, for the purpose of applying the flexible surface presented by the vibrator structure a sponge-rubber pad and a metal plate of predetermined curvature are used, said curvature substantially coinciding with the curvature of a bodily area to be treated by said structure, or serving some special purpose of treatment such as nasal irradiation, irradiation of the knee, or achieving predetermined depth-focusing by convergent setting of the vibrators in the structure, the metal plate of said structure consisting of a deformable material such as lead and the whole structure being arranged to be either secured by elastic members to the bodily area to be treated or pressed there-against by a resiliently-operating stand.

20. An oscillator or vibrator structure wherein one or more oscillators or vibrators as claimed in any of Claims 1 to 16 are arranged to radiate obliquely and either directly or through an intermediate layer or recesses into a metal plate or strip of pedetermined configuration or adapted to be flexed into a desired shape, the thickness, material and angle of radiation of the plate being such that the said plate is excited with flexional waves which are radiated into the body to be treated through a coupling fluid adapted to be carried in and emerge from the vibrator or from the edges thereof, either directly or through an intervening coupling chamber filled with the coupling fluid.

21. A structure as claimed in Claim 20 wherein the coupling chamber comprises a leaden edge, a rubber gasket and a length of tube, means being provided for heating the coupling fluid in the chamber and for forcing said fluid through said chamber by compression or suction.

22. A structure as claimed in Claim 20 or 21 and arranged for the generation and propagation of tangential waves, the coupling chamber being so formed that a very oblique approximately tangential radiation into the area of the body to be treated is obtained, or that elastic centres such as minute air bubbles, a metallic net, or the like, are artificially introduced into the coupling medium in the vicinity of the surface of the body.

23. A structure as claimed in any of Claims 20 to 22 wherein the coupling medium is enclosed in a bladder of very thin rubber detachably or permanently mounted on the oscillator or vibrator and wetted with oil or a gel-like substance such as water with added material such as tragacanth, or aluminium monostearinicum which is carried in the vibrator itself and is supplied therefrom to the body treated.

24. In combination a structure or arrangement as claimed in any of the preceding claims wherein there is a vibrator and high-frequency generator and a diagnostic instrument such as a sound-image reciver with point scanning.

25. A combination as claimed in Claim 24 and including a very sensitive power-meter whereby diagnostic conclusions as to the nature of the medium irradiated can be derived from the power radiated, or wherein the modulation of the radiated supersonic output as the areas of the body to be treated are swept is rendered acoustically observable by means of amplifiers and rectifiers, to enable diagnostic conclusions to be drawn as to the interior of the area treated, or wherein, by means of a sensitive power-meter, a conclusion as to the histological strength of a specimen of tissue can be drawn from the limit of power required to produce turbidity in a liquid in which said histological specimen is suspended when said liquid is subjected to the vibratory radiation.

26. An oscillator or vibrator apparatus as claimed in any of Claims 1 to 23 employed in combination with iontophoresis, wherein the oscillator or vibrator is itself utilised as an electrode, whilst the electrophoretic substance is placed between the body and the said oscillator or vibrator or emerges from the oscillator or vibrator or its edge, or (in the case of a flexible oscillator or vibrator structure) is pressed as an electrode on to a so-called impregnated paper (a paper impregnated with a medicament and for application to the skin, or in the case where a coupling chamber is used wherein the electrophoretic substance is accommodated in the said coupling chamber.

27. An oscillator or vibrator apparatus as claimed in any of Claims 1 to 23, employed in combination with diathermy or short waves, wherein the transmission of sound to the area to be treated is effected via a balanced or tuned adapter or attachment or via an insulating coupling fluid, for such purposes as the treatment of protruding tumours from the side, perpendicularly to the axis of impingement of the ultrasonic radiation,

by means of electrodes incorporated in insulating side walls of the coupling chamber.

28. Supersonic oscillators and vibrators and electro-medical apparatus incorporating the same substantially as herein described with reference to the accompanying drawings.

CARPMAELS & RANSFORD,
Agents for Applicants,
24, Southampton Buildings,
Chancery Lane, London, W.C.2.

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684,165 COMPLETE SPECIFICATION
1 SHEET
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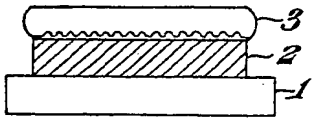

Fig. 1.

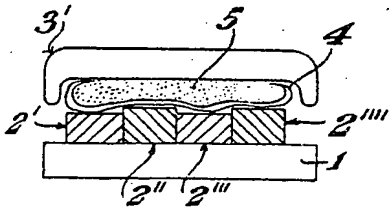

Fig. 2.

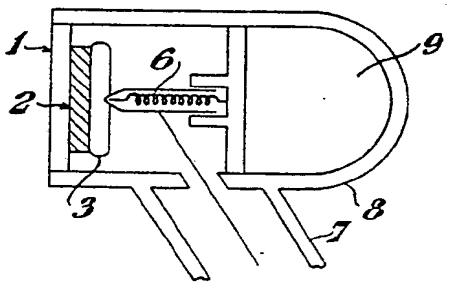

Fig. 3.

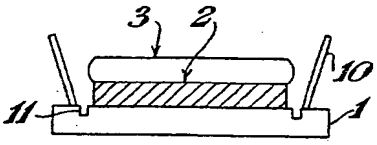

Fig. 4.

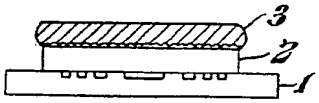

Fig. 5.

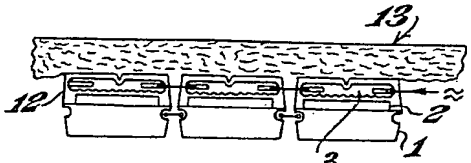

Fig. 6.

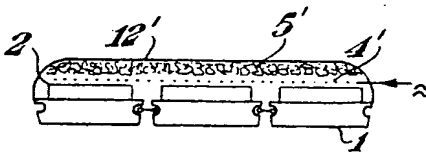

Fig. 7.

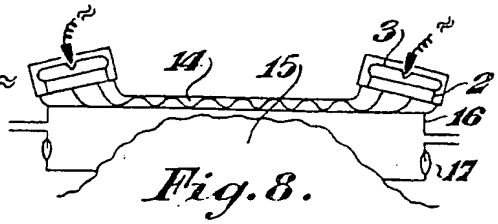

Fig. 8.